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APPLICATION NUMBER: ***60/525,179***
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

17548 U.S. PTO 60/525170 112803

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Amiram	CARMON	Jerusalem, Israel

Additional inventors are being named on the second *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Method and System for Patterning an Organic Light Emitting Diode Display by Printing

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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OR

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 9 ☐ CD(s), Number

☑ Drawing(s) *Number of Sheets* 2 ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.

☑ A check or money order is enclosed to cover the filing fees.

☑ The Director is herby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 14-0112

☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE Amount ($): 80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted

SIGNATURE

TYPED or PRINTED NAME Marvin C. Berkowitz

Date November 28, 2003

REGISTRATION NO. 47,421 *(if appropriate)*

Docket Number: 25848

TELEPHONE 202-775-8383

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PROVISIONAL APPLICATION COVER SHEET
Additional Page

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Docket Number 25848

INVENTOR(S)/APPLICANT(S)

Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
2) Eli	VRONSKY	Ramat Hasharon, Israel

Number 2 of 2

MAIL STOP PROVISIONAL PATENT APPLICATION
Attorney Docket: 25848

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Amiram CARMON and Eli VRONSKY

Serial Number: NOT YET ASSIGNED

Filed: November 28, 2003

Title: METHOD AND SYSTEM FOR PATTERNING AN ORGANIC LIGHT EMITTING DIODE DISPLAY BY PRINTING

TRANSMITTAL LETTER

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
PPP
Commissioner:

Submitted herewith for filing in the U.S. Patent and Trademark Office are the following PROVISIONAL APPLICATION:

1) Transmittal Letter
2) Provisional Application Cover Sheet
3) 11 page Provisional Application consisting of:
   8 pages Textual Specification
   1 page of 8 claims
   2 sheets drawings
4) Check No. 19853 $ 80.00 for filing fee as a small entity
5) Postcard for early notification of serial number

The Commissioner is hereby authorized to charge any deficiency or credit any excess to Deposit Account No. 14-0112

Respectfully submitted,
NATH & ASSOCIATES PLLC

By: 

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Method and system for patterning an Organic Light Emitting Diode display by printing

FIELD OF THE INVENTION

This invention relates to Organic Light Emitting Diodes (OLED).

BACKGROUND OF THE INVENTION

Flat displays are now achieving the stage whereby they become a commodity. In large sized devices, most familiar is the LCD panel that substitutes for CRTs in computers and plasma displays which substitute for CRTs in very large sized TV sets. There are also small instruments that use flat panels of the LCD type- mobile telephones and PDA's.

All these are based on the same patterning principle: the screen is divided into a matrix of sub millimetric picture elements ("pixels") arranged along rows and columns which are electronically addressed according to the rows and columns in a "passive matrix", or individually as is the case in "active matrix" displays. The addressing involves specialized electronics and software.

Such addressing is required to allow the displayed image to be changed and dynamic. In the case of LCDs, the pixelized structure is inherent in the display design. The same is true for plasma displays which are made of thousands of gas filled cells, which must be addressed individually.

A recent development in the field of displays is the so-called Organic Light Emitting Diode display (OLED). OLED displays are based on organic materials that emit light when electric currents excite them. For the present application, it is sufficient to mention that OLED displays whose organic material is made of conjugated polymers (referred to as PLED displays) can be

manufactured by ejecting a solution of the polymer through tiny nozzles such as available in ink jet mechanisms.

US patent 5,902,688 (Antoniadis *et al.*) published May 11, 1999 and entitled "*Electroluminescent Display Device*" discloses an electroluminescent display device having anode, cathode, insulator and organic electroluminescent layers. A patterned insulating layer is interposed between the anode and the hole ejection layer or between the cathode and the electron ejecting luminescent layer. Such insulating layer may be made of photoresist epoxy material that can be patterned in production by exposure to UV light through a mask.

Where UV light strikes the photoresist, it will be "cured" (hardened) and the remaining, unexposed photoresist is washed away. This leaves a patterned insulated layer that inhibits emission of light in the patterned area, thus creating a display of complementary pattern to the non-insulated area.

US patent 6,501,218 (Duggal *et al.*) published December 31, 2002 and entitled "Outdoor *Electroluminescent Display Devices*" describes an OLED display where the anode, cathode or both are patterned so that light will be emitted only in the region of patterned electrode.

In both cases, the result will be a display depicting either the area of discontinuation in the insulating layer, or the area of the patterned electrode. To the observer the visual impression is the same whether the patterned image is done as a "negative" in the case of insulating material or as a "positive" as in the case of patterned electrode.

The creation of patterned insulating layer or a patterned electrode requires usage of masks and multistep processing, and the need to change masks if different patterns are to be used in different displays. Moreover, in the case that more than one color is to be used in different regions both methods proposed are extremely difficult to use, or even impossible.

Furthermore, both proposed methods require full coating with the expensive luminescent material, even when only a part of the coating is to be used actually.

OLED display panels which are based on light emitting polymers have a relatively simple multilayer structure as depicted in Fig. 1 and comprise:

1. A transparent glass or plastic material base layer.

2. A relatively transparent anode made of Indium-Tin Oxide (ITO) which is deposited on the transparent layer by sputtering.

3. A hole ejection layer, ultra thin coat of "PEDOT" (polyethylene-thioxythiophene) or similar material. Such layer can be made by spin coating, doctor blade coating or by ejection from ink jet mechanisms.

4. An electron ejection layer, which is the luminescent layer, made of conjugated polymers or phosphorilated conjugated polymers.

5. A cathode made of Ca, Au or Al deposited by sputtering on layer 4, or applied as a foil. This layer, as well as layer 4 do not need to be transparent

6. A sealing layer (not shown) that seals the other layers from water and oxygen.

The thickness of all layers combined can be sub millimetric, and if plastic material is selected for the base, this type of flat panel display can be folded or made to conform to curved surfaces.

Most of the currently available PLED flat panel displays are structured to have multiplicity of addressable picture elements so that the display is changeable along the temporal dimension, up to the level where superb video images can be displayed.

Here, too, in order that a changing image can be displayed dynamically, address electrodes must be provided in order illuminate selected pixels.

There are situations where a fixed unchanging image is required to be displayed. Examples are conventional still images as are displayed in advertising hoardings, museum artifacts and other similar exhibits, to name but a few. In

such case, the provision of address lines and their associated circuitry is redundant and unnecessarily complex and expensive.()

SUMMARY OF THE INVENTION

It is an object of the invention to use OLEDs for the display of fixed images.

It is another object of the invention to display fixed images using a pixelized display whose pixels are not addressable.

It is yet another object of the invention to use an OLED to display a fixed image by printing the image.

To these ends, the invention discloses an OLED that lends itself to easy and cost saving design of a fixed patterned display. The patterning of the displayed image can be done differently for each individual display, as the manufacturing process is as simple as printing by ink jet on paper. The invention proposes a way of patterning that eliminates addressing by row and columns or the individual addressing of pixels and requires very few electrodes, even as few as two.

Such a display does not require power consuming back light as required by Liquid Crystal Displays (LCDs), and can be battery operated in contrast to the high power a plasma discharge panel requires. Thus, flexible patterning of such a display according to the invention can facilitate new applications, some of which are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a pictorial representation of a prior art OLED display panel based on light emitting polymers having a relatively simple multilayer structure;

Fig. 2 depicts a pattern in the form of the letter "A" that is obtained by printing of the luminescent material;

Fig. 3 is a pictorial representation showing creation within a fixed printed pattern also sub-patterns of illumination by controlling at any point the thickness of the PPV layer; and

Fig. 4 shows pictorially provision of gradual illumination using screening.

DETAILED DESCRIPTION OF THE INVENTION

Essentially, the invention proposes the use of PLEDs for the display of fixed images permitting a very simple addressing scheme in comparison to conventional pixelized displays.

As a result, the invention achieves the following advantages:

1. Different patterns can be created on different display elements under software control.

2. In the case where the pattern to be viewed does not occupy all the display area, the luminescent material in the non-functional areas is saved.

3. Multi-color complex images can be created and viewed without the need to use a multiplicity of electrodes or electronic addressing elements, as long as the image is fixed.

The invention relies on the utilization of ink jet technology to print patterns of the electroluminescent material ("layer 4" above) as desired to depict a clear active light images. There is need for only one anode and one cathode that cover the total area of the display. There is also a continuous coating with the hole injection layer, so the patterning can be made just by selective coating of the luminescent material.

This can be achieved by injecting the luminescent material (PPV) using an ink jet mechanism. The PPV can be dissolved in a solution with low enough viscosity to make it injectable by an ink jet mechanism. However, as it dissolves in aggressive solvents, most ink jet mechanisms are not suitable for this purpose.

The inventors have found an ink jet mechanism that is made solely of glass and silicon, and where instead of glues, electronic bonding of the parts is employed to be suitable. Ink jet mechanisms employed to carry out the invention should be such that they will not be damaged by, or contaminate, the PPV solution. It has been found that these *desiderata* are met by an ink jet mechanism made of electronically bonded silicon and glass such as PL-128 of Industrial Ink Jet Technology of Israel.

Using the ink jet mechanism, a pattern composed of the electroluminescent layer can be quickly achieved. As each single display is individually printed, patterns can be the same or different on different displays, and this is achieved by software control of the print. The displays are activated electrically just by passing current between the continuous cathode and the continuous anode of the display.

Fig. 2 depicts a pattern in the form of the letter "A" that is obtained by printing of the luminescent material.

Having a micro jetting mechanism with a resolution of 600 dpi and drops of a few pico-liters, it is possible not only to simply inject the PPV solution but also to form a PPV layer with uniformity that will enable uniform color and brightness where needed. This is achieved by controlling the number and size of the droplets at each point.

Printing of the PPV material in a pattern which does not occupy the total area of the display results in areas where the PEDOT layer is in direct contact with the cathode. Therefore, in such areas the cathode and anode are separated only by the thin partially conductive PEDOT layer. This "partial shorting" can result in wasting of energy in areas without illumination. To eliminate this energy loss, it is possible to print the areas outside the desired pattern with a non conjugated polymer which acts as an insulator.

As depicted in Fig. 3, the ability to precisely control the thickness of the PPV luminescent layer makes it is possible to create within the fixed printed pattern also sub-patterns of illumination.

Wherever the layer is thin, the illumination is weaker than in the areas where the layer is thicker. This sub-patterning is achieved by enhancing the luminance and not by degrading it as described in UK Patent application no. 2,384,115 where patterned UV light exposed through a mask is used to render some parts of the display to be less luminous. In the present invention the opposite occurs. The ink jet patterning is used to increase luminance by creating patterns with more of the luminous PPV materials.

Still another way to enable gradual illumination can be provided by using a screening and dithering method analogous to that used in conventional printing. The material is injected in form of discrete dots, and the level of illumination increases with the density of the dots. Thus, as shown in Fig. 4, the closer the dots (denser screen) the higher is the illumination.

Novel Embodiments Enabled by the Invention

The invention allows not only the creation of illuminated signs and markers of uniform color as suggested by above-mentioned US patents 5,902,688 and 6,501,218, but also creating sign and markers made of more than one color. This enables the use of different colors from different nozzles to create the desired patterns, as PPV with different colors are commercially available. The ink jetting mechanism may be made of several ink jet heads, each connected respectively to a differently colored PPV solution.

In principle, by using three separate ink jet heads having R, B G colors, respectively, it is possible also to print a pattern in the form of colored picture with a similar resolution and detail obtained by ink jet printing with C, M, Y and K printed on paper as is done conventionally. The difference is that the printed picture of the OLED can be such that each printed dot does not reflect back

colored light, but is luminous whenever a current is passed between the cathode and anode of the display.

Such a picture is "fixed" and is not dynamically changeable as in a matrix display. This difference is due to the fact that only two non-addressable electrodes are required in the invention and not multiple rows and columns of electrodes as in passive matrix display; nor is a separate transistor required for each pixel as in an active matrix display. Furthermore, no software and drivers to actuate the display of the invention are needed, in contrast to complex software and many drivers which are required by matrix type OLED displays.

Thus in such cases where the depicted image on the display is static and fixed *a priori*, the device of the invention is to be preferred over the conventional matrix activated OLED display owing to its simplicity and lower cost.

This aspect of the invention can be exploited in novel products including framed or unframed self illuminated static pictures and self illuminated greeting cards which can be manufactured individually or in bulk, all of which are enabled by a digitally controlled method of printing the luminous "ink" without the need to address selectively the picture elements.

While the invention has been described with particular regard to the use of ink jet technology to produce a fixed image on an OLED display, it is to be understood that other printing techniques may be used provided that each pixel of the resultant picture may be controlled to have the precise color composition, i.e. R, G, B balance so that when voltage is applied between the composite anode and cathode, each pixel will emit light of the desired color. Thus, appropriate printing techniques may also include color offset printing, for example.

CLAIMS:

1. Use of an OLED display for the display of fixed images.

2. A pixelized display displaying a fixed image composed of pre-recorded pixels that are not addressable.

3. The display according to claim 2, being an OLED display.

4. The display according to any one of claims 1 to 3, wherein the image is a multi-color image.

5. A method for creating a fixed image composed of pre-recorded pixels that are not addressable, by printing the image on an OLED display.

6. The method according to claim 5, wherein the printing is done using ink jet technology for injecting a luminescent material in the OLED display.

7. The method according to claim 5 or 6, wherein the image is a multi-color image.

8. The method according to any one of claims 5 to 7, wherein the image is first pre-processed by screening and dithering as in conventional printing.

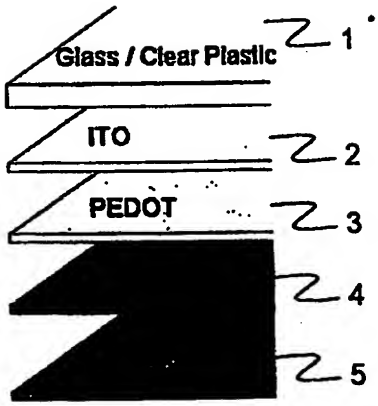
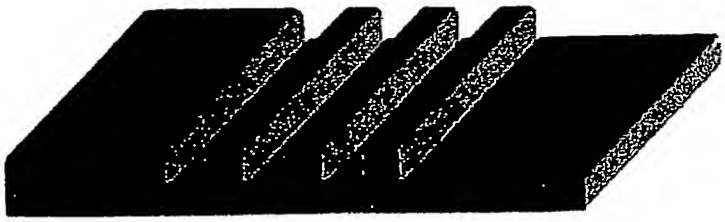
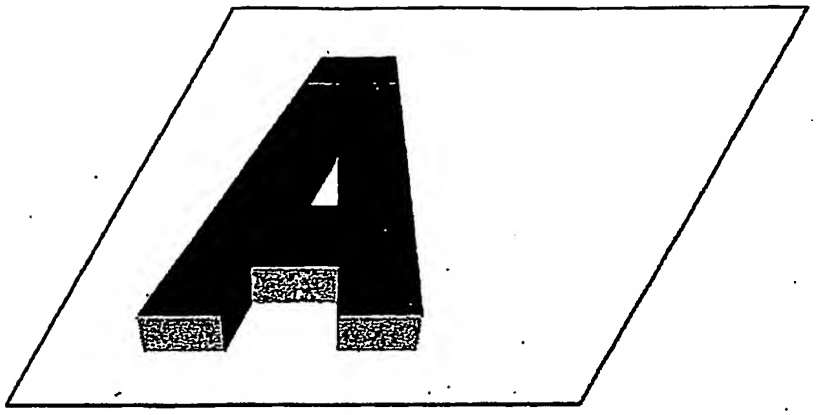


Fig. 1



Pattern Created By Different Thickness Pattern Of PPV

Fig. 2



Patterned PPV Layer

Fig. 3

Screen pattern of RGB of fix color picture

Fig. 4